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EXAMINER

MOORE, PATRICK M

ART UNIT

PAPER NUMBER

2188

DATE MAILED: 06/06/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

|                              |                     |                     |  |
|------------------------------|---------------------|---------------------|--|
| <b>Office Action Summary</b> | <b>Applicant(s)</b> | <b>Applicant(s)</b> |  |
|                              | 10/698,897          | HSU ET AL.          |  |
|                              | <b>Examiner</b>     | <b>Art Unit</b>     |  |
|                              | Patrick M. Moore    | 2188                |  |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 29 March 2006.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-18 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-18 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |   |   |
|---|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)                        | 4) <input type="checkbox"/> Interview Summary (PTO-413)                     |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)    | Paper No(s)/Mail Date. _____  |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____   | 6) <input type="checkbox"/> Other: _____                                    |

### DETAILED ACTION

1. Claims 1, 10-12, 16 & 17 have been amended.
2. Claims 1-18 are pending.

### *Response to Amendment*

3. Applicant's amendment and arguments, filed on **29 March 2006** in response to the Office Action mailed on **29 December 2005**, have been fully considered with the result that follows.

### *Claim Rejections - 35 USC § 103*

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

4. Claims 1-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over unpatentable over Saulsbury et al. (US Patent # 5,900,011), herein **Saulsbury**, in view of **Lamberts** (US Patent # 6,418,510) and further in view of **Smith** (US Patent # 5,394,531).

- a. **As per Claim 1, Saulsbury** discloses a cost-adaptive cache, comprising: a partitioned real cache [**Saulsbury: Figure 1, # 104 & Column 2, Lines 29-33**]; and a partitioned phantom cache to provide a directory of information pertaining to blocks of data which do not qualify for inclusion in the real cache [**Saulsbury: Figure 1, # 106 & Column 2, Lines 34-38**], whereby the partitions in the phantom cache correspond to the partitions in the real cache [**Saulsbury: Column 2, Lines 37-38**]. **Saulsbury** defines a victim cache to be functionally identical to the "phantom cache" claimed by Applicant. However, **Saulsbury**

does not expressly disclose using the replacement cost to prioritize data stored in a cache.

- b. **Lamberts** teaches that data is stored in each of the real cache partitions according to a replacement cost of the data; and the cost-adaptive cache maximizes performance in a system by preferentially caching data that is more costly to replace [**Lamberts: Column 4, Lines 11-18**]. **Saulsbury** and **Lamberts** are analogous art because they are from the same field of endeavor: optimizing cache memories to increase computer performance. At the time of invention, it would have been obvious to a person of ordinary skill in the art to modify the victim data cache of **Saulsbury** to include the cost function calculations taught by Lambert. The suggestion/motivation for doing so would have been to reduce the total access time for data stored in a computer system, which is explicitly stated by **Lamberts** in Column 4, Lines 29-37.
- c. However, **Saulsbury** and **Lamberts** do not expressly disclose the using the replacement cost to define partition size in a cache, but **Smith** teaches that the sizes of the real cache partitions are adjusted based on the replacement cost of the data [**Smith: Column 2, Lines 62-68**]. Note that **Smith** refers to the partition's cost value as a hit/miss ratio, which is based on the number of times a data block is requested.
- d. Furthermore, **Saulsbury**, **Lamberts** and **Smith** are analogous art because they are all from similar problem solving areas: increasing computing efficiency through the optimized use of cache memories. At the time of invention, it would

have been obvious to a person of ordinary skill in the art to modify the victim data cache of **Saulsbury**, combined with the cost adaptive techniques of **Lamberts**, by using the dynamic partition segmentation disclosed by **Smith**. The suggestion/motivation for doing so would have been to increase the hit/miss ratio of the data stored in a cache memory by adjusting the cache partition sizes as is directly disclosed by **Smith** in Column 2, Lines 54-61.

- e. *Finally, identical motivation to combine **Saulsbury** with **Lamberts** and **Smith** applies to each of the subsequent dependent claims, below as Claims 2-15.*
- f. **As per Claim 2, Lamberts** further discloses the cost-adaptive cache of claim 1 wherein the real cache comprises a variable number of blocks for storing data [**Lamberts: Column 4, Lines 61-68**].
- g. **As per Claim 3, Lamberts** further discloses the cost-adaptive cache of claim 1 wherein the real cache includes a configurable number of partitions [**Lamberts: Column 6, Lines 55-663**].
- h. **As per Claim 4, Lamberts** further discloses the cost-adaptive cache of claim 3 wherein the configurable number of partitions are identified according to a replacement cost of data included within each of the partitions [**Lamberts: Figure 3, # 60, 62 & Column 7, Lines 36-38**].
- i. **As per Claim 5, Smith** further discloses the cost-adaptive cache of claim 3 wherein the partitions each have a pair of associated replacement cost values which define the boundaries for each of the partitions [**Smith: Column 2, Lines 62-68**].

- j. **As per Claim 6, Saulsbury** further discloses the cost-adaptive cache of claim 1 wherein the total size of corresponding partitions in the real cache and the phantom cache are less than or equal to the total size of the real cache **[Saulsbury: Column 15, Lines 25-30]**.
- k. **As per Claim 7, Smith** further discloses the cost-adaptive cache of claim 1 wherein a target size is associated with each of the partitions in the real cache and the target sizes can be fixed, dynamic or adjusted periodically **[Smith: Column 2, Lines 62-64]**.
- l. **As per Claim 8, Lamberts** discloses the cost-adaptive cache of claim 1 further comprises maintaining hit/miss statistics for each of the partitions in the real cache and each of the partitions in the phantom cache **[Lamberts: Column 3, Lines 23-34]**.
- m. **As per Claim 9, Lamberts** discloses the cost-adaptive cache of claim 1 further comprises moving blocks between partitions within the real cache and the phantom cache in response to hits and misses in the caches **[Lamberts: Column 3, Lines 35-37]**.
- n. **As per Claim 10, Smith** further discloses the cost-adaptive cache of claim 9 further comprises adjusting the sizes of the partitions in the real cache to minimize an overall cost of servicing data requests **[Smith: Column 3, Lines 43-53]**, and **Lamberts** discloses wherein the overall cost comprises the number of times data is requested and a cost of satisfying each of the requests **[Lamberts: Column 7, Lines 19-29]**.

- o. **As per Claim 11, Lamberts** further discloses the cost-adaptive cache of claim 10 wherein the adjustment [**Lamberts: Column 7, Lines 51-52**] is based on hit/miss statistics of the partitions [**Lamberts: Column 3, Lines 35-37**] and the relative replacement cost of blocks in the partitions [**Lamberts: Column 7, Lines 19-29**].
- p. **As per Claim 12, Lamberts** further discloses the cost-adaptive cache of claim 10 wherein the adjustment is based on a stack distance of a hit in the phantom cache [**Lamberts: Column 3, Lines 42-49**].
- q. **As per Claim 13, Saulsbury** further discloses the cost-adaptive cache of claim 9 wherein when a data block is evicted from the real cache, it is moved into the corresponding partition in the phantom cache [**Saulsbury: Column 2, Lines 37-38 & Column 8, Lines 4-9**].
- r. **As per Claim 14, Saulsbury** further discloses the cost-adaptive cache of claim 13 wherein a block of data can be evicted from the phantom cache in order to make room for the data block evicted from the real cache [**Saulsbury: Column 3, Lines 6-12**].
- s. **As per Claim 15, Lamberts** further discloses cost-adaptive cache of claim 1 wherein the replacement cost of a block of data is obtained by observing the length of time needed to service a request for that data [**Lamberts: Column 7, Lines 19-29**].
- t. **As per Claim 16, Saulsbury** discloses a method for dynamically partitioning a storage system cache according to a replacement cost associated with data

stored in the cache, the cache holding the data as blocks of data, the method comprising the steps of: maintaining a history of recently evicted data blocks for each partition [**Saulsbury: Column 8, Lines 4-9**]. **Lamberts** discloses assigning data to one partition based on a cost associated with not keeping the data in the cache [**Lamberts: Column 7, Lines 19-29**]; determining a future size for each partition based on the history and the cost associated with not keeping the data in the cache [**Lamberts: Column 7, Lines 19-29**]; and whereby the cache's performance is dynamically maximized by preferentially caching data that are most costly to replace [**Lamberts: Column 4, Lines 29-37**]. **Smith** discloses adjusting a real size of each partition based on the determined future size for each partition [**Smith: Column 2, Lines 62-68**]

- u. *As for Claims 16-18, identical motivation to combine **Saulsbury** with **Lamberts** and **Smith** exists as noted above for Claims 1-15.*
- v. **As per Claim 17, Smith** further discloses the method of claim 16 wherein the future size of each partition is determined so as to minimize an overall cost of servicing requests for data [**Smith: Column 3, Lines 43-53**], and **Lamberts** discloses that the overall cost comprises the number of times the data is requested and a cost of satisfying each of the requests [**Lamberts: Column 7, Lines 19-29**].
- w. **As per Claim 18, Lamberts** further discloses the method of claim 16 wherein the cost of not keeping the data in the cache is obtained by observing the length of



time needed to service a request for that data [**Lamberts: Column 7, Lines 19-29**].

***Response to Arguments***

5. Applicant's arguments filed **29 March 2006** have been fully considered but they are not persuasive.

- a. With regards Applicant's traversal of the victim cache disclosed by **Saulsbury**, a phantom cache does receive data blocks from Applicant's real cache, as claimed in Applicant's **Claim 9**. Furthermore, Applicant teaches (in Page 7, ¶3 of the Specification) that the phantom is operated as a victim cache. Examiner maintains that the claimed phantom cache is functionally identical to the victim cache taught by **Saulsbury**.
- b. With regards to Applicant's traversal of **Saulsbury's** discussion of partitioning based on cost, Examiner directs Applicant to **Section 4(b)** of this Office Action for details about the cost-based caching disclosed by **Lamberts**. Specifically, **Lamberts** teaches storing blocks based on a cost function [**Lamberts: Column 4, Lines 11-18 & 38-55**].
- c. With regards to Applicant's traversal of **Lamberts'** partitioning of the cache based on cost, Examiner directs Applicant to **Section 4(c)** of this Office Action for details about the cost-dependent partitioning disclosed by **Smith**. Further, Examiner highlights that **Saulsbury** teaches Real and Phantom Caches, **Lamberts** teaches a specific cost function with dynamic cache boundaries and **Smith** teaches a cost-dependent (known as hit/miss) partition size.

- d. With regards to Applicant's traversal of a motivation to combine **Lamberts** with **Saulsbury**, Examiner directs Applicant to **Section 4(b)** of this Office Action for an explicit motivation to combine: for the benefit of reducing the total data access time.
- e. With regards to Applicant's traversal of **Smith's** cache partitioning criteria, Examiner directs Applicant to **Sections 4(c) & 4(d)** of this Office Action for details about the sizing criteria taught by **Smith**. In addition, **Smith** teaches altering the size of a cache partition based on data cost (known as a hit/miss ratio).

As described above and in Section 4 of this Office Action, Examiner has made a prima facie showing of obviousness for the combination of **Saulsbury**, **Lamberts** and **Smith**.

#### ***Conclusion***

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

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the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

*Mano Padmanabhan*  
8/30/06

**MANO PADMANABHAN  
SUPERVISORY PATENT EXAMINER**